

REMARKS

In the last Office Action, the Examiner withdrew claims 28-33 from further consideration as being directed to a non-elected invention. Claims 13-14 and 24-25 were rejected under 35 U.S.C. §112, second paragraph, for indefiniteness. Claims 1-5, 12-15 and 21-22 were rejected under 35 U.S.C. §103(a) as being unpatentable over Zhang (USPN 6,682,871) in view of the publication to Miller et al. ("Miller"). Claims 6-11, 17-20 and 23-27 were rejected under 35 U.S.C. §103(a) as being unpatentable over various combinations of the references to Zhang and Miller in view of various references to Kim et al., Raynaud et al., Atobe et al., Pfoff, Mansel et al., Bolle et al., Cunningham et al., Powell et al., Holke et al., Cho et al., Little et al., Nakayama et al., Seshan, Wikipedia, and Society of Vacuum Coaters. Claim 16 was objected to as being dependent upon a rejected base claim, but indicated to be allowable if rewritten in independent form including all of the limitations of the base and intervening claims. Additional art was cited of interest.

Applicants and applicants' counsel note with appreciation the indication of allowable subject matter concerning claim 16. However, for the reasons noted below, applicants respectfully submit that amended claims 1-15 and 17-27 and newly added claims 34-39 also patentably distinguish from the prior art of record.

In accordance with the present response, the specification has been suitably revised to correct informalities, provide antecedent basis for the claim language, and bring it into better conformance with U.S. practice. Allowable claim 16 has been rewritten in independent form to incorporate the subject matter of base claim 1. Claims 1-27 have also been amended to overcome the rejection under 35 U.S.C §112, second paragraph, in formal respects to improve the wording, and to bring them into better conformance with U.S. practice. Non-elected claims 28-33 have been canceled without prejudice or admission and subject to applicants' right to file a continuing application to pursue the subject matter of the non-elected claims. New claims 34-39 have been added to provide a fuller scope of coverage. A new abstract which more clearly reflects the invention to which the amended and new claims are directed has been substituted for the original abstract.

Applicants request reconsideration of their application in light of the foregoing amendments and the following discussion.

The present invention relates to a method of manufacturing a mirror. As described in the specification (pgs. 1-4), conventional methods for manufacturing a mirror, such as a micro-mirror, have not been able to provide a micro-mirror having high verticality and low surface roughness.

The present invention overcomes the drawbacks of the conventional art. Figs. 1-5 show an embodiment of a method for manufacturing a mirror embodied in the claims. A mask material 4 is formed on a surface 30 of a silicon substrate 3. The silicon substrate 3 is then anisotropically dry etched to form a surface 23 disposed substantially parallel with a crystal face 31 perpendicular to the surface 30 of the silicon substrate 3. Thereafter, the silicon substrate 3, including the surface 23 and the crystal face 31, is subjected to anisotropical wet etching to form a reflection surface 26. By this method, the reflection surface 26 that is obtained has high verticality relative to the surface 30 of the silicon substrate and a low surface roughness.

According to another feature of the invention embodied in the newly added claims, during the anisotropical dry etching step the substrate 3 is subjected to deep groove etching to provide concavely-formed indented portions (see Fig. 1B) in the surface 23. The concavely-formed indented portions are then removed during the anisotropical wet etching step which forms the reflection surface 26 (see Fig. 1C). By this method, the surface roughness of the reflection surface 26 is further reduced.

Amended claims 1-15 and 17-27 patentably distinguish from the prior art of record.

Amended independent claim 1 is directed to a method of manufacturing a mirror having a reflection surface vertical to a surface of a silicon substrate. The method requires a step of forming a mask material on a surface of the silicon substrate, an anisotropic dry etching step of anisotropically dry etching the silicon substrate to form a surface disposed substantially parallel with a crystal face perpendicular to the surface of the silicon substrate, and an anisotropic wet etching step of anisotropically wet etching the silicon substrate including the crystal face and the surface disposed substantially parallel with the crystal face to form a reflection surface. No corresponding combination of steps is disclosed or suggested by the prior art of record.

In each rejection of the claims under 35 U.S.C. §103(a), the Examiner cited the reference to Zhang which teaches a DRIE step (i.e., anisotropic dry etching) in the manufacture of a mirror, and the reference to Miller which teaches the use of anisotropic wet etching in the formation of a reflection surface. Thus, while Zhang discloses an anisotropic dry etching step and Miller discloses an anisotropic wet etching step, neither Zhang or Miller teaches the use of both an anisotropic dry etching step and an anisotropic wet etching step in a method of manufacturing a mirror having a reflection surface vertical to a surface of a silicon substrate, as recited in amended independent claim 1.

Furthermore, in addition to not teaching the use of both an anisotropic dry etching step and an anisotropic wet etching step in a method of manufacturing a mirror having a reflection surface vertical to a surface of a silicon substrate, the references do not disclose or suggest an anisotropic wet etching step after an anisotropic dry etching step, as recited in independent claim 16. As described in the specification and reiterated herein, this novel combination of steps used in the claimed manufacturing method achieves a mirror with a reflection surface of low surface roughness as compared to the conventional art.

With respect to dependent claims 2-15 and 17-27, the Examiner cited the references to Kim et al., Raynaud et al., Atobe et al., Pfoff, Mansel et al., Bolle et al., Cunningham et al., Powell et al., Holke et al., Cho et al., Little et al., Nakayama et al., Seshan, Wikipedia, and Society of Vacuum Coaters as teaching the various features recited in these claims. However, as claims 2-15 and 17-27 depend on and contain all of the limitations of amended independent claim 1, these claims distinguish from the references at least in the same manner as claim 1.

In view of the foregoing, applicants respectfully submit that the rejections of claims 1-15 and 17-27 as being unpatentable over various combinations of the references to

Zhang, Miller, Kim et al., Raynaud et al., Atobe et al., Pfoff, Mansel et al., Bolle et al., Cunningham et al., Powell et al., Holke et al., Cho et al., Little et al., Nakayama et al., Seshan, Wikipedia, and Society of Vacuum Coaters have been overcome and should be withdrawn.

Applicants respectfully submit that new claims 34-39 also patentably distinguish from the prior art of record.

Claims 34-35 depend on and contain all of the limitations of amended independent claim 1 and, therefore, distinguish from the references at least in the same manner as claim 1.

Moreover, there are separate grounds for patentability of new claims 34-35. Claim 34 includes the additional limitation that during the anisotropic dry etching step the surface of the silicon substrate is scalloped, and that during the anisotropic wet etching step the scalloping formed on the surface of the silicon substrate is removed. Claim 35 includes the additional limitation that the anisotropic dry etching step includes the step of deep groove etching the silicon substrate to provide concavely-formed indented portions, and that the anisotropic wet etching step includes the step of removing the concavely-formed indented portions. No corresponding steps are disclosed or suggested by the prior art of record.

New independent claim 36 is directed to a method of manufacturing a micro-mirror and requires the steps of forming a mask material on a surface of a silicon substrate, anisotropically dry etching the silicon substrate to obtain a crystal face having concave indented portions and being disposed substantially parallel with a second crystal face disposed generally perpendicular to the surface of the silicon substrate, and anisotropically wet etching the silicon substrate to remove the concave indented portions from the first crystal face and form a reflection surface comprising the second crystal face. No corresponding combination of steps is disclosed or suggested by the prior art of record as set forth above for amended independent claim 1 and new claims 34-35.

Claims 37-39 depend on and contain all of the limitations of independent claim 36 and, therefore, distinguish from the references at least in the same manner as claim 36.

In view of the foregoing amendments and discussions,
the application is now believed to be in allowable form.
Accordingly, favorable reconsideration and passage of the
application to issue are most respectfully requested.

Respectfully submitted,

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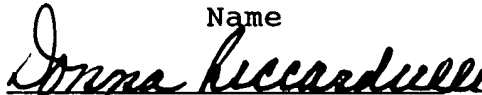
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